QCD, EW and Tools at 100 TeV
CERN
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Top production at large p_t at 100 TeV

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Large-p_t top @ FCC

How far in p_t shall we measure top at the FCC at 100 TeV?

Total cross section ~ 30 nb (a factor of ~ 30 w.r. t. LHC 14 TeV)

- $d\sigma/dp_t$ at 1 TeV @ FCC ~ 0.1 pb/GeV ~ $d\sigma/dp_t$ at 400 GeV @ LHC
- $d\sigma/dp_t$ at 2 TeV @ FCC ~ 1 fb/GeV
- $d\sigma/dp_t$ at 6 TeV @ FCC ~ 1 ab/GeV

Large-p_t theoretical issues

For $p_t \gg m$ enhanced quasi-collinear gluon radiation is possible even from top quarks

$\Rightarrow \alpha^n \log^{n-k}(p_t/m)$ terms in series

How big are they?
How do we deal with them?

FONLL

Quasi-collinear logs from gluon emission off heavy quarks have been resummed in FONLL for charm and bottom

Ingredients: a massive fixed order calculation, a 'massless' resummed calculation, a proper matching:

FONLL = FO + RS - double counting

Orders and logs

A matched calculation can be written as

fixed order resummed

$$N^kLO.N^mLL = N^kLO + N^mLL \text{ - double counting}$$

What is known for $d\sigma/dp_t$?

$N^kLO.N^mLL$ for $d\sigma/dp_t$

k	m	Label	Known since
0	-	LO	1978/79 multiple authors
1	-	NLO	1989 Nason, Dawson, Ellis
1	1	NLO.NLL	1998 MC, Greco, Nason (this is 'FONLL')
2	-	NNLO	2015 Czakon,Fiedler, Heymes,Mitov
1	2	NLO.NNLL	Ingredients exist. Doable in principle
2	1	NNLO.NLL	
2	2	NNLO.NNLL	

FONLL for top at FCC

Upgrade of FONLL to v1.4 (not yet released)

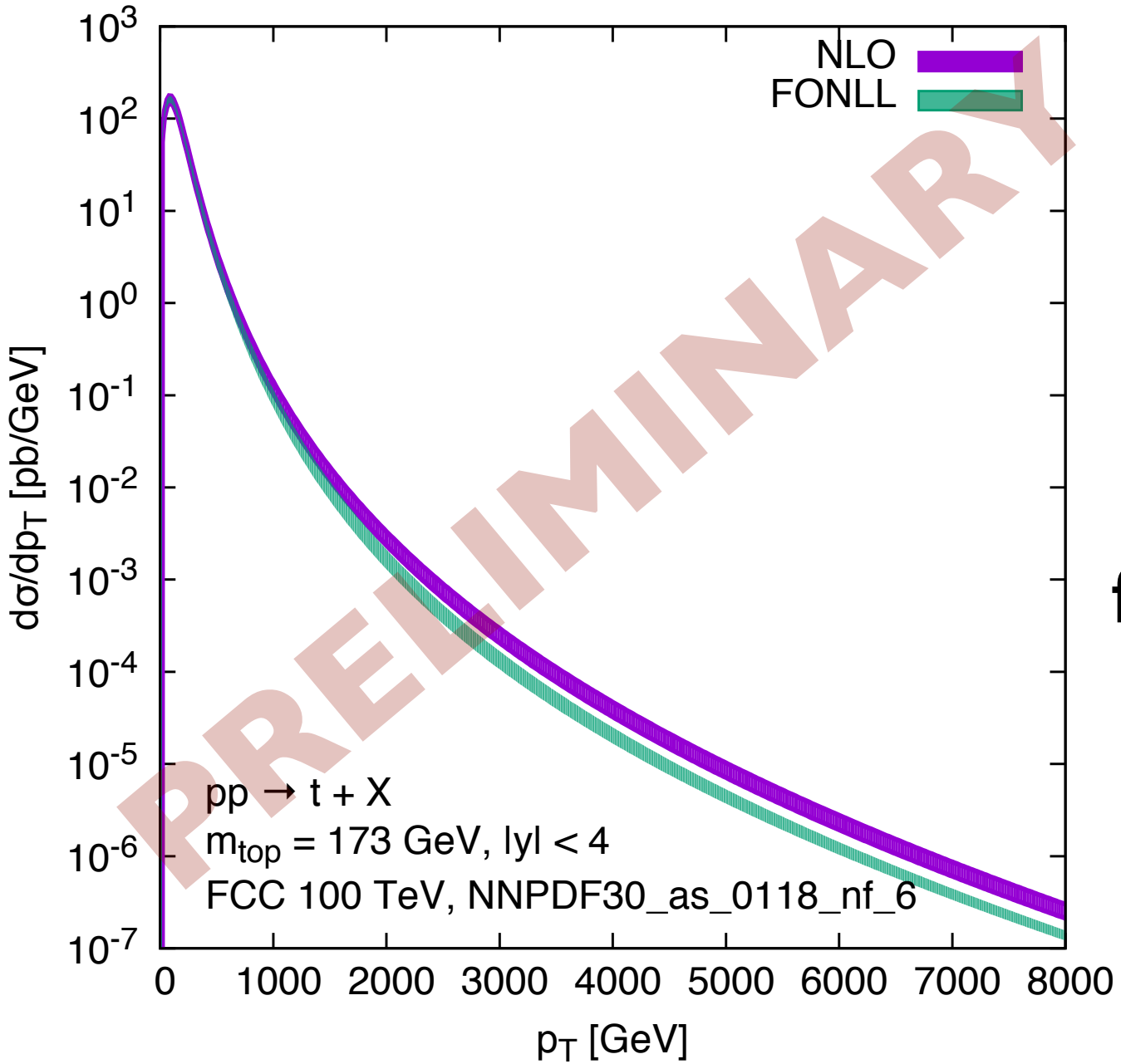
Ingredients needed for top quark production:

- 6 light flavours running in α_s
- PDFs with 6 flavours (top quark perturbatively generated)
  - NNPDF30_as_0118_nf_6
  - CT14nlo_NF6
  - others?

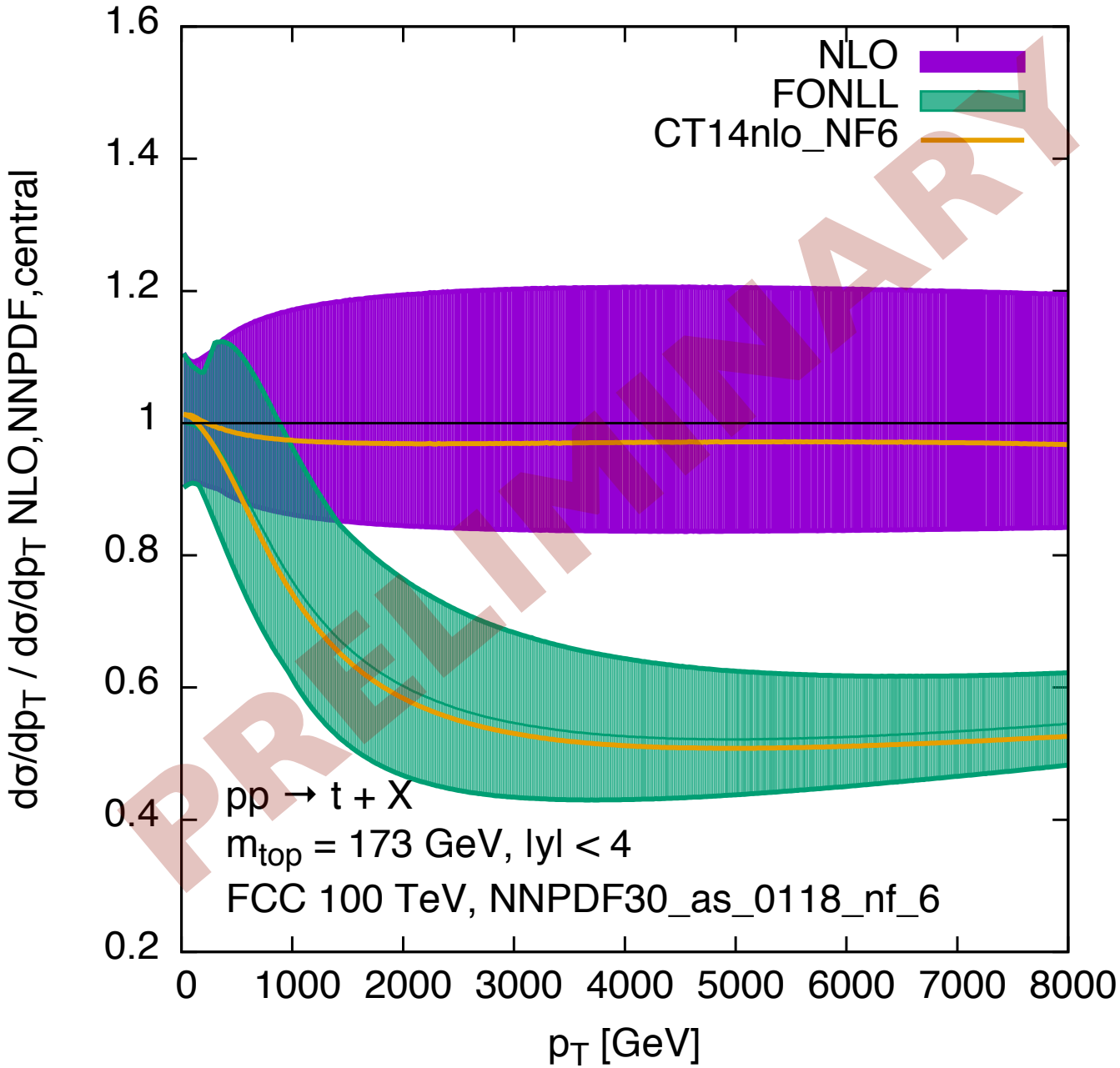
Disclaimer

all plots in the rest of the talk
highly preliminary

‘Preliminary’ as in
‘I suspect some may actually
be incorrect’



Uncertainty band: 7-points rule for fact. and ren. scales

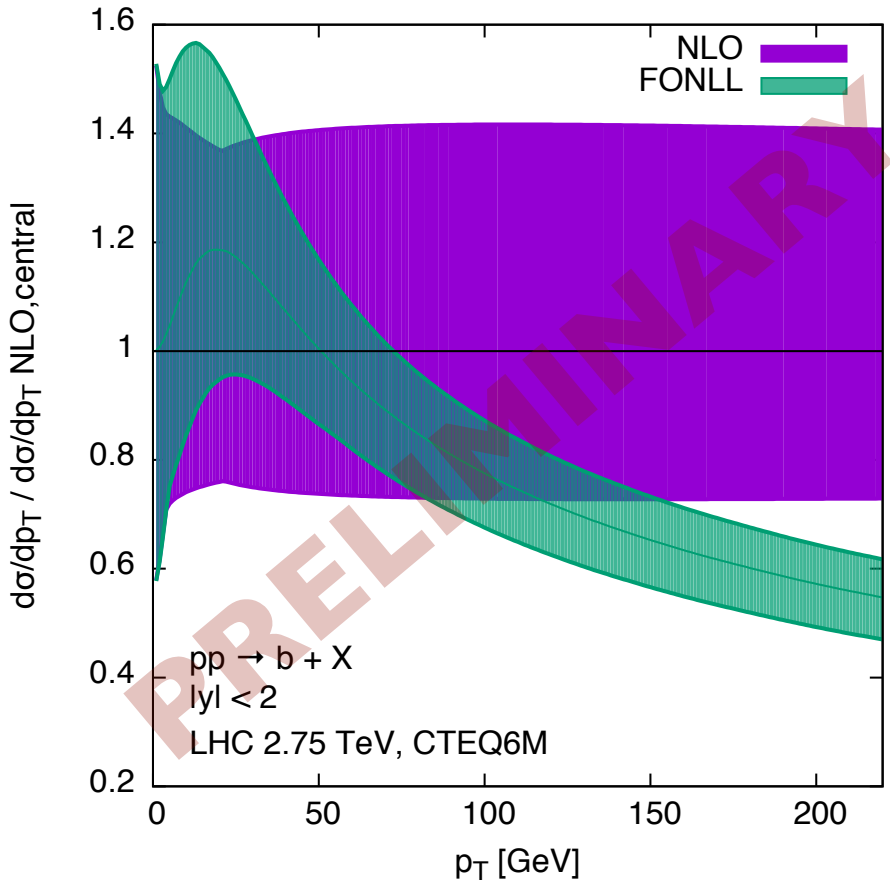


Factor of 2 reduction in rate w.r.t. NLO for $p_t > 2$ TeV

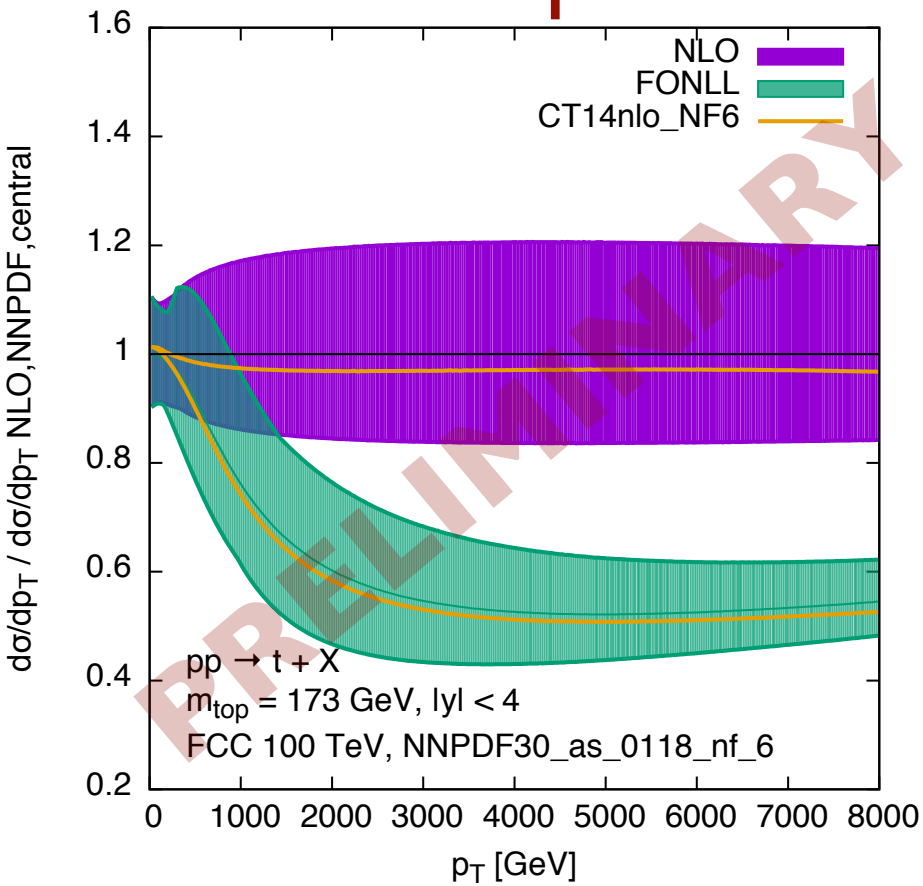
Really?

Compare to bottom quarks at 2.75 TeV CM energy and p_t up to 200 GeV

bottom



top



Effect of quasi-collinear logs for top sets in a lot earlier as a function of p_t/m?

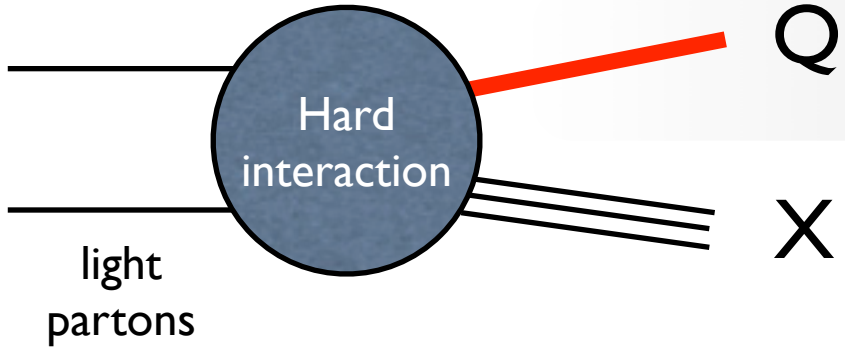
Conclusions

- FONLL upgraded to calculate top
- It runs at 100 TeV
- Seems to predict large effects from quasi-collinear resummation
- Still needs to be checked/debugged ('hidden traps'?)
- Once debugged, can complement fixed order predictions for $d\sigma/dp_t$

Backup

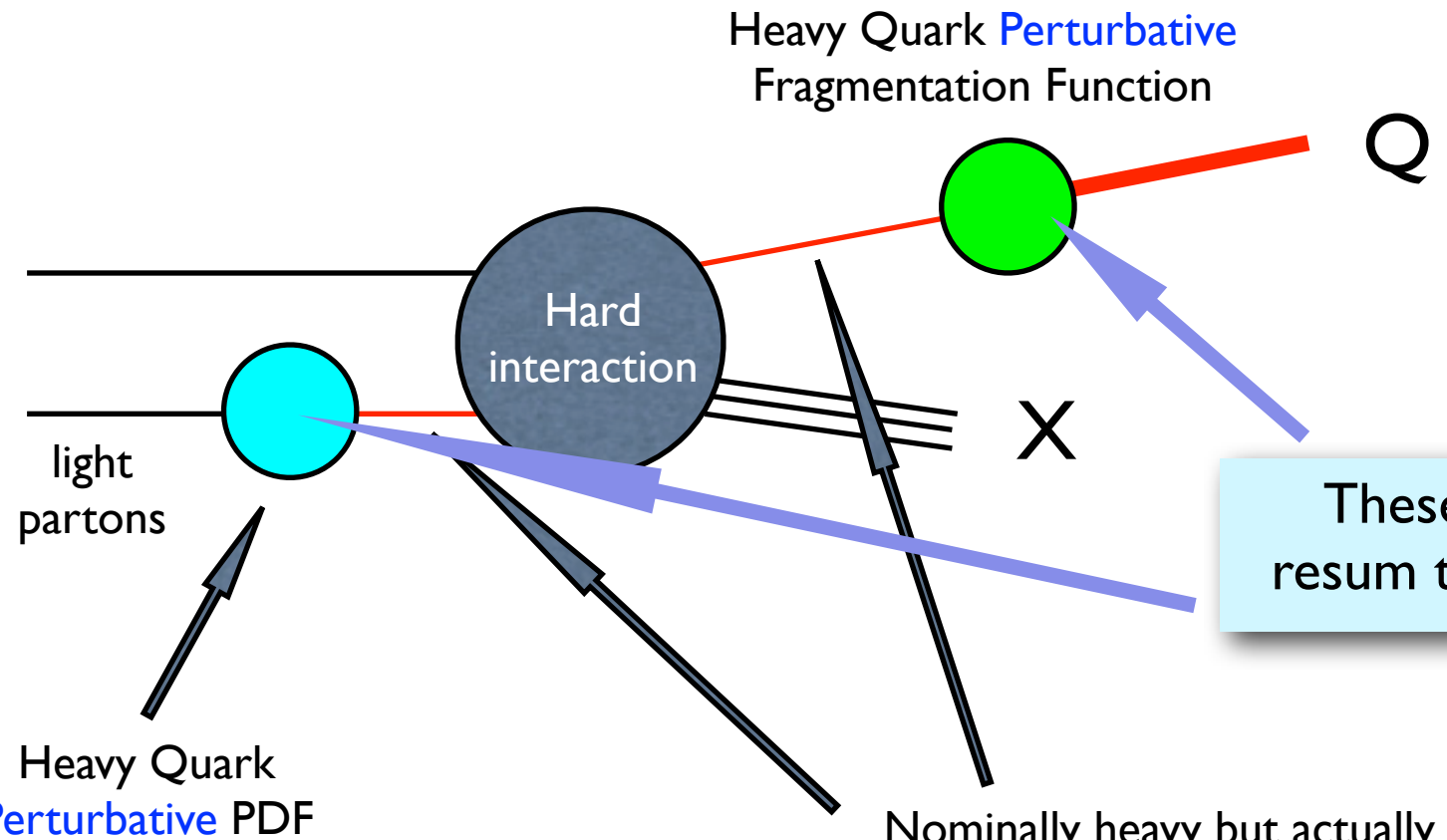
FONLL

FO



+

NLL



- double-counting

(accurate at NLO+NLL)